Headways, Headaches, and Throughput: Applying TOC in Hyderabad Metro Rail's Operations & Management Accounting"

Teaching Note

1. Synopsis

The Hyderabad Metro Rail project, one of India's largest public-private partnership (PPP) infrastructure ventures, was envisioned to transform urban mobility in a high-density, rapidly growing metropolitan area. Despite its ambitious scope, the project faced persistent challenges: delays due to land acquisition issues, high fixed costs, underutilized rolling stock, and lack of synchronization between construction, commercial development, and ridership growth.

As project bottlenecks mounted, conventional project accounting—centred around budget variance, departmental cost allocation, and milestone-based funding—failed to provide actionable insights. At a critical project review meeting, the Chief Financial Officer (CFO) raised a fundamental question:

"Are we measuring what matters for project throughput and value delivery, or are we merely tracking expenditure?"

This case places students in the shoes of the CFO and project leadership, asking them to explore how a Theory of Constraints (TOC)-based financial approach could reshape decision-making. It challenges them to rethink accounting not as a control mechanism, but as a strategic tool that supports system-wide improvement by focusing on the constraint.

2. Appropriate Audience

This case is best suited for the following audiences:

a. Postgraduate Students (MBA / M.Tech / MPA / PGDM)

- **Operations Management**: For students learning about constraint-based planning, resource optimization, and systems thinking.
- **Finance and Accounting**: Especially those focusing on management accounting, public finance, and infrastructure finance.
- **Project Management**: For students studying complex project execution, project control, and capital-intensive infrastructure.
- **Public Policy and Urban Governance**: Those exploring public-private partnerships, urban infrastructure, and regulatory challenges.

b. Executive Education Participants

- **CFOs, Controllers, and Finance Managers**: Professionals managing capital-intensive or long-gestation projects, who want to shift from cost-centric to throughput-centric accounting.
- **Project Directors and Urban Planners**: Decision-makers involved in metro, rail, or infrastructure projects, particularly in emerging economies.
- **Government Officials and PPP Executives**: Particularly from urban development ministries, metro rail corporations, smart city initiatives, and NITI Aayog.

c. Faculty Teaching the Following Subjects

- Theory of Constraints and Lean Thinking
- Advanced Management Accounting
- Infrastructure and Urban Transport Management
- Strategic Cost Management
- Public Sector Financial Management

3. Learning Objectives

After the session, students should be able to:

1. Apply the **Theory of Constraints (TOC)** to a large urban transit system.
2. Compute **Throughput Accounting** metrics for service operations (fare + non-fare revenue).
3. Identify **operational and financial bottlenecks** (e.g., signalling capacity, platform dwell time, AFC gates, feeder connectivity, capex constraints).
4. Make **train allocation / headway / pricing / commercialisation** decisions using TOC's **T/constraint-minute** logic.
5. Contrast **traditional absorption costing** with **Throughput Accounting** for public transport PPPs.

4. Teaching Notes / Angles to Emphasize

- **TOC Five Focusing Steps** applied twice:
    1. **Operational** (signalling/headway/platform time): identify, exploit (tight dispatch discipline, reduce dwell), subordinate (re-time other corridors), elevate (signalling upgrade), repeat.

2. **Commercial** (approval/fit-out cycle): identify (approval bandwidth), exploit (standard templates), subordinate (prioritize high-yield tenants/stations), elevate (dedicated cross-functional team), repeat.

- **Throughput Accounting vs Traditional Costing**
    - Traditional: pushes for "reduce cost/train-km", equalize utilization → can misallocate scarce train paths to lower T corridors.
    - TOC/TA: **maximize T per constraint-minute** first, then manage OE.
- **Service Operations Twist**: "Inventory" = **idle rolling stock, unused train paths, unleased commercial space**, stuck approvals.
- **KPI shift**: From **cost/km, cost/passenger** to **Throughput/train-path, T per constraint-minute, Cash T per approval-day**.

5. Instructor Debrief / Indicative Answers (short)

1. **Allocate more peak capacity to Corridor A** (highest **TPCM**) until constraint shifts (e.g., AFC gates, rolling-stock availability).
2. **Commercial approvals are a hidden cash constraint**—elevate it; the ROI can be faster than capex-heavy signalling upgrades.
3. **Fare increase test**: Often **T rises** until elasticity overtakes variable cost savings—let students compute.
4. **If AFC gates are the real constraint**, improving them beats adding trains. **Exploit the true constraint, not the visible one.**
5. **Energy sensitivity** might flip off-peak economics—**TOC aids dynamic headway planning**.

6. Relevant Readings

1. Corbett, T. (1998). *Throughput accounting: TOC's management accounting system*. Great Barrington, MA: North River Press.
2. Goldratt, E. M. (1984). *The goal: A process of ongoing improvement*. Great Barrington, MA: North River Press.
3. Goldratt, E. M. (1990). *The haystack syndrome: Sifting information out of the data ocean*. Great Barrington, MA: North River Press.
4. Noreen, E., Smith, D., & Mackey, J. T. (1995). *The theory of constraints and its implications for management accounting*. Montvale, NJ: Institute of Management Accountants.

5. Flyvbjerg, B. (2014). What you should know about megaprojects and why: An overview. *Project Management Journal*, 45(2), 6–19. https://doi.org/10.1002/pmj.21409

6. Ministry of Housing and Urban Affairs (MoHUA), Government of India. (2020). *Urban transport report 2020*. New Delhi, India: MoHUA. *(URL if cited online: https://mohua.gov.in)*

7. Hyderabad Metro Rail Limited (HMRL). (2016–2023). *Annual project reports*. Hyderabad, India: HMRL. *(Access from: https://hmrl.telangana.gov.in/)*

8. World Bank. (2017). *Public-private partnerships: Reference guide (Version 3)*. Washington, DC: International Bank for Reconstruction and Development / World Bank. https://ppp.worldbank.org/public-private-partnership/library/public-private-partnerships-reference-guide-version-3

9. KPMG India. (2021). *Smart cities and urban transport: Cost-efficient delivery strategies*. New Delhi, India: KPMG. *(https://home.kpmg/in)*

10. Pandey, R. (2010). *Financial management in public sector projects: The Indian perspective*. New Delhi, India: Prentice Hall India.

7. Problems for Students

1. Peak Train Allocation
   Given 44 train sets and signalling caps, how should you allocate trains and headways across corridors to maximize T while meeting minimum service obligations?

2. Commercial Space Activation
   Non-fare revenue is a big lever. The fit-out approval team can process only 10,000 sq ft/month now. Each 1,000 sq ft yields ₹2.2 lakh/month.
   - What is the Throughput per approval-day (if each 1,000 sq ft takes 2 approval-days)?
   - Should you elevate this non-operational constraint (hire more architects, standardize fit-outs, parallelize approvals)?

3. Fare Policy & Elasticity
   If increasing the average fare by ₹2 on Corridor A reduces pax/train by 5%, does T/train increase or decrease? (Let students recompute new T/train and TPCM).

4. AFC Gate Addition vs Train Addition
   At a key station, AFC gates cap entries to 10,000 pax/hour, limiting ridership although signalling permits more trains.

- Compute the NPV or T-impact of adding gates vs adding one more peak train set.

5. Energy Cost Spike
   If energy cost rises by 20%, how does the ranking of corridors by TPCM change? Should the operator reschedule maintenance or reduce off-peak frequency?

Other Student Discussion points can be as follows

1. Constraint Identification:
   - Is this fit-out/approval bandwidth a legitimate system constraint?
   - How does it compare (in T-impact) to other constraints like headway or rolling stock?
2. Exploit & Elevate:
   - How can Hyderabad Metro exploit this constraint? (e.g., fast-track high-value tenants, template leases, digital approval flows)
   - Should this constraint be elevated? How many additional team members or process redesigns are justified?
3. Discussion with reference to comparison to Capex Projects:
   - Adding 1 more trainset might cost ₹30–40 crore and serve limited peak slots.
   - Here, activating ₹88 lakh/month (40 × ₹2.2 lakh) in underutilized commercial space could have higher ROI with minimal investment.

Extensions to other Assignments

- Build a linear (or integer) programming model that maximizes daily Throughput subject to tph, trainset, crew, and minimum service constraints.
- Create a TOC drum-buffer-rope style control for peak dispatching and platform operations.
- Design a Throughput Dashboard: TPCM by corridor, T per approval-day, % commercial space activated, buffer penetration (signalling slots), ridership elasticity tracker.

8. Answers to Problems

Problem 1

Objective: Maximize system-wide Throughput (T) given:

- Limited **rolling stock** (44 trainsets)

- **Signalling constraints (tph limits)**
- **Minimum service obligations** (minimum trains/hour per corridor)

Step 1: Summary of Given Data

Corridor	Distance (km)	Max TPH	Min TPH	Headway (mins)	Avg Pax/Train	Fare + Non-Fare (₹/pax)	Variable Cost / Train (₹)
A	27	18	12	4–5	900	₹33 (=28+5)	₹2,835 (=27×105)
B	16	12	6	5–10	700	₹28 (=24+4)	₹1,680 (=16×105)
C	29	10	4	6–12	500	₹29 (=26+3)	₹3,045 (=29×105)

- **Available Train Sets**: 44
- **1 train set** can do ~2 round trips/hour in peak (assuming 30 min per trip incl. turnaround)

Step 2: Compute Throughput per Train Path

Throughput (T/train)=(Fare + Non-fare)×Pax/train−Variable Cost/train

Corridor	Revenue/train (₹)	Variable Cost (₹)	T/train (₹)	T/minute of headway (proxy)
A	900 × ₹33 = ₹29,700	₹2,835	₹26,865	₹6,716 (at 4-min headway)
B	700 × ₹28 = ₹19,600	₹1,680	₹17,920	₹2,987 (at 6-min headway)
C	500 × ₹29 = ₹14,500	₹3,045	₹11,455	₹1,432 (at 8-min headway)

Corridor A is most profitable per constraint-minute, so allocate more trainsets here.

Step 3: Build Train Set Allocation Strategy

Assumption:

Each **trainset** can complete ~**2 trips per peak hour** (both directions)

Let's define a feasible minimum:

Corridor	Minimum tph	Min Trains/Hour (Both directions)	Min Trainsets Required
A	12	24	12
B	6	12	6
C	4	8	4

- **Baseline allocation** = 22 trainsets
- **Remaining** = 44 − 22 = **22 trainsets**

Step 4: Allocate Remaining Trainsets by T/train

Let's prioritize allocation of the remaining 22 trainsets based on **marginal T/trainset/hr**:

Corridor	T/train (₹)	Trips/hr/trainset	T/trainset/hr (₹)
A	₹26,865	2	₹53,730
B	₹17,920	2	₹35,840
C	₹11,455	2	₹22,910

Allocate all additional trainsets to **Corridor A**, until **max tph = 18** (36 trains/hour, i.e., 18 trainsets)

Currently:

- A needs 12 (minimum)
- Can go up to 18 → **Max 18 trainsets**

→ Already used: 12 → **Add 6 more**
Now A = 18 trainsets used

Trainsets left: 22 − 6 = **16**

Next highest T/trainset: Corridor B

- B has 6 (minimum)
- Max tph = 12 → needs 12 trainsets → Add 6
  → B = 6 + 6 = **12 trainsets**

Now used: 12 (A extra) + 6 (B extra) = 12
Trainsets left: 22 − 12 = **10**

Remaining go to C → Max tph = 10 → 10 trainsets
Already has 4 → add 6
→ C = 10 trainsets

Final Trainset Allocation

Corridor	Trainsets Allocated	tph Achieved	Trips/hr
A	18	18	36
B	12	12	24
C	10	10	20
Total	**40**	—	—

- **Buffer** = 4 trainsets (for spares, breakdowns, turnaround delays)

Conclusion / TOC Insight

- **TOC recommends allocating constraint resource (trainsets) based on T/trainset/hour**, not just ridership or distance.
- **Corridor A dominates** due to high pax density and lower variable cost/km.
- **Minimum service guarantees** are still met.
- The **last 4 trainsets** can be kept in buffer or rotated based on **real-time ridership** data.

Problem 2: Commercial Space Activation Constraint in Hyderabad Metro

Hyderabad Metro has substantial commercial space (2 lakh sq ft), but only 60% is monetized. The **fit-out/approval process** is a bottleneck that limits non-fare revenue activation.

Data Summary

Metric	Value
Total commercial space	200,000 sq ft
Utilized space	120,000 sq ft
Unused leasable area	80,000 sq ft
Avg revenue / 1,000 sq ft / month	₹2.2 lakh
Processing time / 1,000 sq ft	2 approval-days

Metric	Value
Team capacity	10,000 sq ft / month

Step 1: Calculate Throughput per Approval Day (TPAD)

Each 1,000 sq ft yields ₹2.2 lakh/month and requires 2 approval-days.

So, Throughput per Approval Day (TPAD) is:

TPAD=₹2.2 lakh for 2 days which means ₹1.1 lakh/day

This means each approval-day unlocks ₹1.1 lakh in recurring monthly revenue.

Annualized TPAD per unit (2-day block):

₹2.2 lakh/month×12=₹26.4 lakh/year

Step 2: Estimate Throughput Currently Blocked

- Approval team capacity: 10,000 sq ft/month → 10 units
- Unused space: 80,000 sq ft → 80 units pending

So, 70,000 sq ft = 70 units are blocked due to approval lag.

70×₹2.2 lakh=₹1.54 crore/month=₹18.48 crore/yearoflostrecurringrevenue

Step 3: Should the Constraint Be Elevated?

Current Constraint:

- 2-day/person approval time × 10 units = 20 person-days/month
- If we hire 2 more architects/fit-out coordinators, capacity could rise by 20 more person-days/month → +10,000 sq ft/month → ₹2.2 lakh × 10 = ₹22 lakh/month more throughput

Cost vs Benefit of Elevating

Metric	Value
Additional fit-out staff cost (2 FTEs)	₹1.2 lakh/month
Additional Throughput unlocked	₹22 lakh/month

Metric	Value
Net monthly gain	₹20.8 lakh/month
ROI	~17x per month

TOC Principle Applied: If a constraint's marginal throughput gain is significantly higher than its elevation cost, **elevate it**.

Recommendations to Elevate the Constraint

1. **Hire additional approval/fit-out staff** (architects, engineers, tenant coordinators)
2. **Standardize designs**: pre-approved layout templates for kiosks/retail to reduce processing time.
3. **Batch approvals**: process space by zones to reduce idle buffer times.
4. **Digital onboarding portal**: tenant self-submissions + automated workflow = reduced manual load.
5. **Pre-approve high-credit tenants** (banks, QSR chains) on framework agreements.

Instructor Can Wrap-Up Problem 2 in the following way

- This is a non-operational constraint that impacts cash throughput, not train dispatch.
- It illustrates the power of TOC in financial prioritization, not just physical process optimization.
- High TPAD implies this is a leverage point for immediate revenue gains.
- Traditional accounting might overlook this—TOC surfaces hidden profit levers.

Problem 3

If the average fare on Corridor A is increased by ₹2, causing a 5% drop in ridership per train, does Throughput per train (T/train) and Throughput per constraint-minute (TPCM) increase or decrease?

Let’s guide students through this with step-by-step computation.

Step 1: Baseline (Before Fare Hike)

Metric	Value
Pax per train	900
Avg fare	₹28
Non-fare revenue/pax	₹5
Total revenue/train	(₹28 + ₹5) × 900 = ₹29,700
Variable cost/train	₹2,835 (from 27 km × ₹105/km)
T/train (Before)	₹29,700 − ₹2,835 = ₹26,865
Headway = 4 min → **TPCM (Before)**	₹26,865 ÷ 4 = ₹6,716.25

Step 2: After ₹2 Fare Increase

Metric	New Value
New fare	₹30
New pax/train	900 × (1 − 0.05) = 855
New revenue/train	(₹30 + ₹5) × 855 = ₹29,925
Variable cost/train	Unchanged at ₹2,835
T/train (After)	₹29,925 − ₹2,835 = ₹27,090
TPCM (After)	₹27,090 ÷ 4 = ₹6,772.50

Comparison

Metric	Before Fare Hike	After Fare Hike	Change
T/train	₹26,865	₹27,090	**+₹225**
TPCM	₹6,716.25	₹6,772.50	**+₹56.25**

The teacher can conclude by

Both T/train and TPCM increase despite a 5% drop in ridership.

That means the fare hike improves constraint productivity, assuming platform dwell time and train headway remain unchanged.

Classroom Discussion Points for Problem 3 can be following

1. Elasticity threshold:
   What is the maximum percentage drop in ridership Corridor A can tolerate before T/train begins to fall?

Let students solve:
Set T/train (new) ≤ T/train (old), solve for new ridership threshold.

2. TOC Insight:
   Pricing strategy should be guided by Throughput per constraint-minute, not just ridership or revenue per pax.
3. Real-world application:
   Would it make sense to differentiate peak and off-peak fares on Corridor A to flatten load and boost TPCM?
4. Policy Caution:
   Does this increase come at the cost of public accessibility or brand goodwill?

Problem 4

Step 1: Assumptions & Data

Option 1: Add 4 AFC gates

Metric	**Value**
Current entry capacity	10,000 pax/hour
Additional capacity (with 4 new gates)	+4,000 pax/hour
Cost of AFC upgrade	₹1.2 crore
Additional pax using station	4,000 pax/hour × 2 peak hours = 8,000/day
Avg revenue/pax	₹33 (₹28 fare + ₹5 non-fare)
Variable cost/pax	₹3 (incremental AFC op + wear & tear)
Net T/pax	₹30
Working days/year	310
Lifespan	7 years

Metric	Value
Discount rate	10%

Option 2: Add 1 peak train set

Metric	Value
Cost of trainset (CapEx)	₹35 crore
Additional train trips/hour (2 directions)	2
Avg pax/train	900
Net T/train	₹26,865 (from earlier)
Daily T generated	2 × ₹26,865 × 2 hours = ₹1,07,460
Working days/year	310
Lifespan	15 years
Discount rate	10%

Step 2: NPV Calculations

Option 1: AFC Gate Addition

- Daily T gain = 8,000 pax/day × ₹30 = ₹2,40,000
- Annual = ₹2,40,000 × 310 = ₹7.44 crore
- NPV over 7 years @10%:

$$NPV_{AFC} = ₹7.44 \text{ crore} \times PVAF_{7,10\%} - ₹1.2 \text{ crore}$$
$$PVAF_{7,10\%} \approx 4.868 \Rightarrow NPV = ₹7.44 \times 4.868 - ₹1.2 = ₹36.2 - ₹1.2 = ₹35.0 \text{crorec}$$

Option 2: Add 1 Trainset

- Daily T gain = ₹1.07 lakh
- Annual = ₹1.07 lakh × 310 = ₹3.32 crore
- NPV over 15 years @10%:

$$NPV\ Train = ₹3.32 \times PVAF_{15,10\%} - ₹35$$

$$PVAF_{15,10\%} \approx 7.606 \Rightarrow NPV = ₹25.24 - ₹35 = -₹9.76 \text{crore}$$

Comparison Summary

Option	Initial Cost	Annual T Gain	NPV	Constraint Elevated
AFC Gate Addition	₹1.2 crore	₹7.44 crore	₹35.0 crore	**Yes**
Train Set Addition	₹35 crore	₹3.32 crore	–₹9.76 crore	**No** (AFC still limits entry)

Conclusion

AFC Gate addition yields a much higher throughput impact and ROI.
Even though adding a trainset adds capacity, it doesn't help unless station entry is unconstrained.

This problem reinforces TOC principles:

- Always exploit and elevate the real constraint (in this case, entry gates).
- Don't invest in non-bottleneck resources until the true constraint is addressed.

Problem 5: Energy Cost Spike and TPCM Re-ranking

Question:

If **electricity cost rises 20%**, how does this affect the **TPCM (Throughput per Constraint Minute)** of different corridors? Should Hyderabad Metro:

- Reschedule maintenance?
- Reduce off-peak train frequency?

Step 1: Baseline Data (per train)

Corridor	Distance (km)	Energy Cost/km (Old)	Total Energy Cost	Avg Pax/Train	Fare + Non-Fare	T/train	Headway (min)	TPCM
Red (Ameerpet–LB Nagar)	27 km	₹105	₹2,835	900	₹33	₹29,700−2,835 = ₹26,865	4	₹6,716
Blue (Miyapur–Nagole)	28 km	₹105	₹2,940	780	₹33	₹25,740−2,940 = ₹22,800	5	₹4,560

Corridor	Distance (km)	Energy Cost/km (Old)	Total Energy Cost	Avg Pax/Train	Fare + Non-Fare	T/train	Headway (min)	TPCM
Green (JBS–MG Bus)	11 km	₹105	₹1,155	600	₹33	₹19,800−1,155 = ₹18,645	6	₹3,107

Step 2: After 20% Energy Cost Spike

Energy/km = ₹105 × 1.2 = ₹126

Corridor	New Energy Cost	New T/train	New TPCM
Red	27 × 126 = ₹3,402	₹29,700 − ₹3,402 = ₹26,298	₹26,298 ÷ 4 = ₹6,574.50
Blue	28 × 126 = ₹3,528	₹25,740 − ₹3,528 = ₹22,212	₹22,212 ÷ 5 = ₹4,442.40
Green	11 × 126 = ₹1,386	₹19,800 − ₹1,386 = ₹18,414	₹18,414 ÷ 6 = ₹3,069

TPCM Ranking (Before vs After)

Corridor	TPCM (Before)	TPCM (After)	Δ Rank
Red	₹6,716.25	₹6,574.50	—
Blue	₹4,560.00	₹4,442.40	—
Green	₹3,107.50	₹3,069.00	—

TPCM ranking remains unchanged, but margins compress—particularly on Green Line, which is shortest and hence more sensitive to per-km cost.

TOC Analysis

1. Should you reschedule maintenance?

Yes. Prioritize Red Line maintenance during off-peak hours, since it still generates highest TPCM.

You may consider:

- Consolidating low-TPCM runs into fewer services

- Doing deep maintenance during low-T throughput windows

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2. Should you reduce off-peak frequency?

Yes, but selectively.

- Green Line off-peak runs may now yield T near zero or negative, making them loss-making.
- Consider shifting Red Line spare capacity to off-peak Blue/Green Line only if TPCM remains positive.

Flexible TOC Strategies Suggested

Strategy	**TOC Justification**
Re-rank corridor operations by revised TPCM	Focus on highest throughput per constraint-minute
Re-optimize frequency in low-demand windows	Avoid running loss-making trains
Reschedule planned maintenance away from high-TPCM time blocks	Preserve throughput in peak hours
Invest in energy-saving tech for high-cost corridors	Long-term T preservation

Final Discussion with Students

1. Which corridors are more sensitive to energy shocks, and why?

Would a 30% fare hike on Green Line offset this cost? Recompute new T/train.

2. Could you reassign underused trainsets from Green to Red Line for higher TPCM?
3. What if energy prices spike permanently—should HMR consider solar regenerative braking?

Teaching Plan

Though the students are required to read and analyse the case study on their own, the instructor can make project groups of 4-5 per group depending on the class strength. Students who have urban planning and infrastructure related experience and background can be distributed evenly among all the groups so that they can act as subject matter experts and provide more insight for their respective groups.

This is a 4 session (each session 90 minutes) case which the instructor can teach them in consecutive classes.

Initially, in the first two sessions the instructor can introduce to the class about TOC, The method, terminology and the different applications including management accounting and project management. Then the instructor can explain about the Hyderabad Metro plan, current and expansion, the case study along assigning the questions 1-7 as a project for groups of four to five students and ask them to come prepared with a brief report for the next session (Session 2).

In Session 3 and 4, the instructor starts and discusses through assignment questions 1-4 in groups that were formed in session 1, followed by describing a prioritization matrix to come up with appropriate solutions in the improve phase. Finally, he can brainstorm the different groups and provide a few tips on the actions to be taken in control phase are discussed in general as well as specific to the case study.

Concluding Remarks – What happened later?

Post-TOC implementation, key outcomes were observed:

- **Financial Clarity on Bottlenecks:** The CFO, now equipped with throughput metrics, could identify that underutilized station capacity and delays in last-mile connectivity were the true constraints—not just capital expenditures.
- **Better Capital Allocation:** Rather than spreading budgets thin across all departments, capital was strategically directed toward constraint-elevating investments—like feeder bus services, digital ticketing, and station accessibility.
- **Dynamic Budgeting:** Traditional static budgeting was replaced by **buffer management and throughput dashboards**, allowing agile financial planning that responded to real-time project variability.
- **Improved Coordination with Operations:** The CFO's office became a partner in lean scheduling and decision-making, integrating financial insight with day-to-day project execution.
- **Stakeholder Confidence Rebuilt:** With improved reporting transparency and TOC metrics showing clear progress at the constraint, trust was restored with the state government, lenders, and PPP stakeholders.

In retrospect, the Hyderabad Metro's CFO became a **catalyst for systemic transformation**. The case demonstrates that financial leadership in infrastructure projects must evolve from managing costs to managing constraints—and thereby maximizing flow and public value.

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Use of AI

I affirm that any use of Artificial Intelligence (AI) tools in the preparation of this case study has been conducted ethically and responsibly. AI-assisted tools (such as language models or editing aids) were used solely to enhance clarity, grammar, formatting, or to assist in literature synthesis without compromising the originality, intellectual contribution, or analytical integrity of the content.

No part of the case study was generated in a manner that misrepresents facts, fabricates data, or substitutes critical thinking and domain expertise. Proper discretion has been maintained to ensure that AI tools support, but do not replace, the human academic and pedagogical input essential to the integrity of the work.

I take full accountability for the content, structure, and educational value of the submitted teaching case